U.S. INFORMATION SERVICES
MARKET ANALYSIS PROGRAM

Discrete Manufacturing

Information Services Opportunities & Trends

1992-1997

INPUT®

1280 Villa Street, Mountain View, CA 94041, (415) 961-3300

MAY 1992

DISCRETE MANUFACTURING

INFORMATION SERVICES OPPORTUNITIES AND TRENDS

1992-1997

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Industry Sector Markets, 1992-1997
Discrete Manufacturing Sector

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I

Introduction

A

Purpose

The basic objectives of this U. S. Information Services Market Analysis Program industry or vertical market report are to:

- Provide an introduction to the discrete manufacturing industry's structure, demographics and key submarkets that are influenced most by the use of information systems
- Identify business issues and trends that are driving the use of information services within the discrete manufacturing industry and key submarkets, and discuss the rapid changes in the use of information technology that information services vendors are now helping to bring about in this industry
- Discuss the use of information systems within the discrete manufacturing industry and key submarkets, particularly in regard to the impact of significant business issues such as continuing low sales rates, restructuring, and the impact of technological trends, particularly client/server use and downsizing
- Discuss the information services market within the discrete manufacturing industry and key submarkets, including market sizing and the factors driving market demand for each delivery mode within the market as a whole
- Discuss the competitive environment and profile leading information services vendors within the discrete manufacturing industry, noting differences among vendors as to strategies, products and submarkets they concentrate on
- Discuss the information services market within the discrete manufacturing industry and key submarkets, including market sizing and the factors driving market demand for each delivery mode within the market as a whole.

B

Methodology

The data on which this report is based was gathered during 1991 and 1992 as part of INPUT's ongoing market analysis program. Trends, market size, and growth rates are based primarily upon in-depth interviews with users within the discrete manufacturing industry.

- INPUT maintains ongoing relationships within the discrete manufacturing industry and the IS vendors serving the discrete manufacturing industry.

- INPUT also maintains ongoing relationships with, and a data base of, all users and vendors that it interviews. Interviewees for the research portion of this report were selected from this data base of contacts.

In addition, extensive use was made of INPUT's corporate library located in Mountain View, California. The resources in this library include several on-line periodical data bases, subscriptions to over 50 computer and general business periodicals, continually updated files on over 3,000 information services vendors, and the most up-to-date U.S. Department of Commerce publications on industry statistics.

It must be noted that vendors may be unwilling to provide detailed breakouts by delivery mode or industry. Also, vendors often use different categories of industries and industry segments, or view their services as falling into different delivery modes from those used by INPUT. Thus, INPUT must estimate revenues by these categories on a best-effort basis. The delivery mode and individual segment forecasts should be viewed as indicators of general patterns and trends rather than as specific, detailed estimates for individual years.

When the information is provided from vendors as requested, at times it is provided under an agreement of confidentiality. Therefore, vendor rankings based on these revenue figures should be considered indicative rather than definitive, and the revenues themselves should be viewed as approximations only.

1. Introduction

The manufacturing industry is generally divided into two primary sectors—discrete and process.

- The most significant difference is that discrete products are manufactured one at a time, even if the process involves a rapidly moving assembly line.

- Process manufacturing products are made as the result of a process. Processes can be either continuous or batch and involve delivery in containers or cans like soup or in large storage containers like oil.

A model of the manufacturing industry is shown in Exhibit I-1. This model separates process and discrete manufacturing into two segments based on the difference in product output.

- There can be similarities between some large-scale repetitive, discrete manufacturing and process manufacturing concerned with products that are delivered in containers or cans.
- While other models may attempt to incorporate similarities as well as differences, this model captures the main distinction between discrete and process types of manufacturing processes.

EXHIBIT I-1

Manufacturing Industry Model

Process	Discrete
Continuous in batches or lots	One or multiple individual units Repetitive, flexible to job shop, custom project

In order to provide more insight into the differences between discrete products (manufactured singly) and process products (based on a continuous or batch process), five characteristics of manufacturing environments are compared in Exhibit I-2.

Key differences that are emphasized by this analysis include:

- Manufacturing methods
- Number and location of plants
- Costs of raw materials
- Computing environments

Although MRP and MRPII computing environments have been a characteristic of many discrete manufacturers, integrated environments including business, engineering and shop floor functions are growing in use.

EXHIBIT I-2

Comparison of Discrete and Process Manufacturing

Characteristic	Discrete	Process
Typical Mfg. Methods	Assembly line	Batch/lot
Plant Structure	Small number of large plants, geographically concentrated	Large number of small plants, as well as some large plants, geographically dispersed
Costs of Raw Materials	Relatively fixed	Variable
MRP/MRPII Computing Environment	Batch-/transaction-oriented	Real-time- /transaction-oriented
Other Factors		• Material substitutions • Formula adjustments • Real-time process monitoring

2. Discrete Manufacturing Description

As shown in Exhibit I-3, the discrete manufacturing industry in the U.S. roughly covers the Standard Industrial Classification (SIC) code numbers 265 through 396, excluding 281 through 291, which refer to process manufacturing industries like food processing, plastic manufacturing and petroleum refining.

Although it is difficult to make many generalizations about the growth rates and usage of IS by all types of discrete manufacturing products, data published by the U.S. Census Bureau or gathered by INPUT may be used to characterize some segments of the discrete manufacturing market further.

- For instance, it appears that the automotive and electronics/instruments submarkets use manufacturing software products in over 50% of establishments.

- A much lower percentage of the companies in the consumer durables industries use such software products.

U.S. discrete manufacturing industry segments vary by their growth rates, as well. This is due to the effects of the current recession and differences between industries.

- During the last few years, fewer than 10% of the U.S. discrete manufacturing industries grew by more than 5%, according to the U.S. Department of Commerce.
- Segments of discrete manufacturing that have grown faster in the recent past include laboratory and medical instruments, printed circuit boards and toys.

EXHIBIT I-3

SIC Groups in Discrete Manufacturing

SIC Group	Description
23xx	Apparel and other finished products
25xx	Furniture and fixtures
27xx	Printing, publishing and allied industries
31xx	Leather and leather products
34xx	Fabricated metal products except machinery and transportation equipment
36xx	Electronic and other electrical equipment and components except computer equipment
35xx	Industrial and commercial machinery and computer equipment
37xx	Transportation equipment
38xx	Instruments; photo, medical, optical goods, watches and clocks
39xx	Miscellaneous manufacturing including toys, games, jewelry and sporting goods

3. Discrete Manufacturing Applications

INPUT's manufacturing model has groups or islands of automation, each of which includes three or four primary applications, as shown in Exhibit I-4.

EXHIBIT I-4

Applications in Discrete Manufacturing

(1) Business operations and planning
- General accounting
- Financial reporting
- Planning
  - MRP and MRPII
  - Scheduling
- Marketing/sales
- Material warehousing and handling
- Purchasing
- Human resources

(2) Engineering and design
- CAD/CAM
- Documentation
- Plant simulation
- Design engineering

(3) Factory floor
- Machine control
- Area control
- Plant monitoring

(4) Other applications
- Plant maintenance
- EDI
- CIM

- In this illustration, the traditional center of activity for IS personnel in manufacturing companies in this scheme is business operations and planning.

- In fact, research has shown that IS departments are often preoccupied with running, maintaining and enhancing large systems that might be

obsolete for general accounting, financial reporting, and planning, and are reluctant, or at times simply incapable, of becoming heavily involved in the other islands of automation within the company.

New technological trends, particularly the use of client/server technology and downsizing, have been changing this situation and have spread even to factory floor operations, where attempts by IS departments to participate in CIM have often been thwarted due mainly to a lack of expertise in these operations.

4. Computer-Integrated Manufacturing

Of increasing importance to companies involved in discrete manufacturing is computer-integrated manufacturing, which really constitutes an approach to both information services and manufacturing within a company.

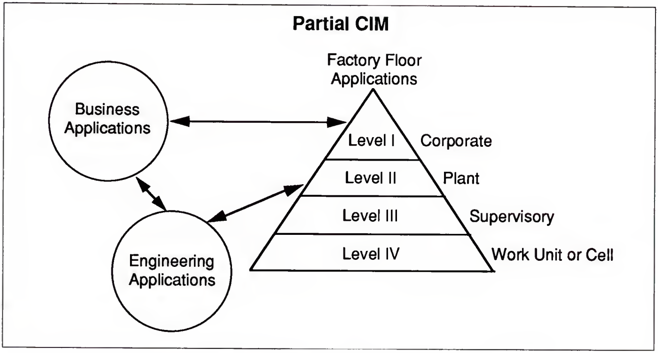
- Numerous models of discrete as well as process factory environments have been developed, some of them quite complex.

- These models represent a trade-off between the level of detail and the ease of understanding of the factory's operation.

As illustrated in Exhibit I-5, INPUT's model uses three groupings or islands of automation:

- Business applications
- Design/engineering applications
- Factory floor applications

EXHIBIT I-5



In the past few years, vendors' sales literature has emphasized complete CIM solutions for the discrete manufacturing sector.

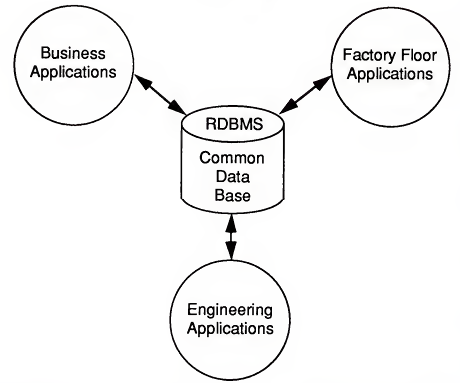
- To some of these vendors, CIM is the link between (a) any two of the three islands of automation or (b) any two of the four levels within factory floor environments depicted in Exhibit I-6.
- A true computer-integrated manufacturing environment will utilize a common data base that is shared by users in business, factory floor, and engineering applications. All three application groups are integrated, as shown in Exhibit I-6.

The growth of redundant files in different islands as well as the same island has made the goal of establishing a single relational data base capability and achieving direct connections between functions so important that these steps are being addressed before CIM or as steps toward CIM at a number of discrete manufacturers.

- The growing number of interconnections and plans to implement CIM have raised questions of standards and the use of open systems, which is also of importance in manufacturing currently.
- IS organizations have become a point of planning for the use of CIM as well as a point of coordination and information for users implementing interconnections through client/server and other technology. Because of this role, many IS organizations have also become the proponents of standards and the use of open systems.

EXHIBIT I-6

Full CIM



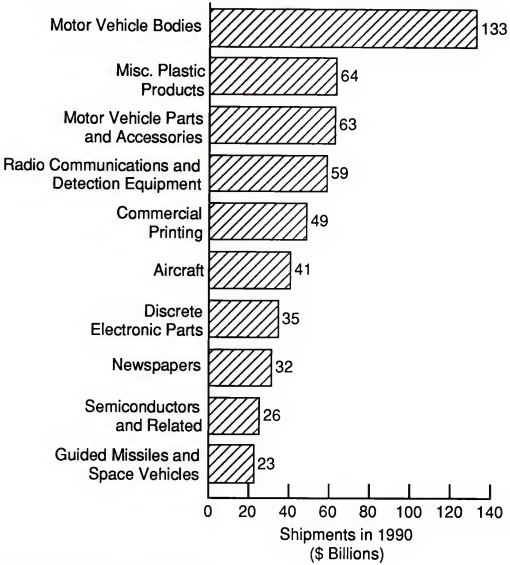
5. Characteristics of the U.S. Discrete Manufacturing Industry

Exhibit I-7 describes some of the largest U.S. discrete manufacturing industries.

- Six of these industries could be classified as highly concentrated with relatively few firms participating, while the others are characterized by a large number of competitors.
- There are 16 other discrete manufacturing industries with 1990 shipments of over $10 billion, and 102 with less than $10 billion.

EXHIBIT I-7

Ten Largest U.S. Discrete Manufacturing Industries



Since it is difficult to analyze all segments of the discrete manufacturing industry, comments regarding factors of importance in the study will often be directed toward the groupings of submarkets that are shown in Exhibit I-8.

- The automotive submarket is often referred to in relation to discrete manufacturing because it is the largest submarket and has a high level of automation.

- Other submarkets have needs or areas of opportunity for increasing use of information technology, including aerospace, where defense cuts are limiting some initiatives.

EXHIBIT I-8

Discrete Manufacturing Submarkets

Submarket Group	Selected Characteristics
• Automotive (includes trucks, buses, trains)	Largest submarket Level of automation Large projects
• Aerospace (includes missiles)	Impact of defense downturn Level of automation
• Electronics (includes radio communications and detection)	Challenges of computer and semiconductor segments Less mature IS environments
• Medical/Instruments (includes all dental, medical and laboratory equipment)	Above-average growth rate Selected areas of opportunity
• Machinery/Metal (includes metal products)	Need for improved automation
• Other (remaining discrete segments)	Good performance in some segments Selected opportunities

C

Organization and Contents of Report

In addition to this chapter, there are five chapters and two appendixes, which are described below:

- Chapter II—Trends, Events, and Issues—provides background information on the business issues and trends driving the use of information services within the discrete manufacturing industry. Forces of a general nature, such as the impact of the U.S. and world economies, and discrete

manufacturing industry-specific forces, such as changes in the modes of delivery of IS and the rate of adoption of automation products and services, are discussed. The section on issues discusses the likely impact of the change in the structure of key segments of the industry.

- Chapter III—Information Systems Environment—provides an overview of the basic business processes in the discrete manufacturing industry, and their supporting information systems applications. The impact of the current economic environment and current budgeting issues in information systems within the discrete manufacturing industry are also discussed.

- Chapter IV—Information Services Market—discusses the discrete manufacturing market in detail, and is divided into the following sections:

  - Overview
  - Environmental Factors
  - Expenditures by Delivery Mode
  - Expenditures by Island of Automation
  - Vendor Analysis

- Chapter V—Competitive Environment—identifies leading IS vendors in the industry, discusses some of the factors that affect the competitive dynamics of the industry, and profiles representative vendors.

- Chapter VI—Conclusions and Recommendations—reviews the trends and opportunities described in the report and provides recommendations for vendors as well as users.

In addition, there are two appendixes:

- Appendix A presents industry-specific definitions used throughout the report.

- Appendix B presents the forecast data base and the forecast reconciliation. The forecast data base covers the 1991-1997 period and includes forecasts of user expenditures by delivery mode for the discrete manufacturing industry as a whole. The forecast reconciliation compares this report's forecast with the forecast provided in INPUT's previous discrete manufacturing report and explains the reasons for variations.

II

Trends, Events, and Issues

A

Overview

Business trends, events, and issues that are currently having an impact on the discrete manufacturing industry are reviewed in this chapter.

- In succeeding chapters, the effect of these factors will be discussed in relation to internal information systems and activities and the use of information systems vendors.

- In general, these factors are encouraging discrete manufacturers to review means of improving sales through better service and product quality as well as means of reducing costs or achieving objectives with lower expenditures through reductions in operations and restructuring or the use, for example, of downsizing and new application technology, in information systems.

B

Issues

IS users in discrete manufacturing report that the promise held out by the information systems function throughout the 1980s of increased productivity has only been partially realized, and other objectives including service, streamlining of ordering and communication between workplace functions have become almost as important, if not more important, than productivity to some companies.

- A number of companies, particularly larger ones, have made significant investments in new robotics or automated design and engineering technology and some have seen significant productivity paybacks.

- Fewer firms have been able to capitalize on CIM, EDI, and JIT technologies, which could hold similar promise but have not been implemented on a large scale. Strategic planning of a broad enough scope to

take advantage of technologies and services that have become available in the last few years does not exist in many U.S. discrete manufacturers.

Current business conditions and the economic climate make it difficult for manufacturers to concentrate only on steps that can improve their manufacturing capability and productivity. According to many users of information systems, the continuing recession in the U.S. and foreign competition are depressing sales in many of the submarkets in discrete manufacturing, as shown in Exhibit II-1.

- The effect of low sales and foreign competition is particularly strong on the automotive and machinery/metal products submarkets and segments of the other submarket category mentioned in Chapter I, including apparel and appliances.
- Factory orders showed no real improvement throughout 1991 and are expected to continue at levels that will keep industry depressed in most of 1992.
- At the end of 1991, the index of purchasing activity of the National Association of Purchasing Managers stood at a level that did not indicate that a recovery was likely in the near future.

Low sales can stimulate activities to recover market share or invade new markets, but IS users report that poor sales have more of a negative than a positive impact on their operations, as indicated in Exhibit II-1. The pressure to reduce costs resulting from the continuing depressed sales has been stronger than the drive for improvements.

- IS users also report that issues of restructuring, reductions in defense expenditures, and mergers and acquisitions are having impacts on their activities that are more negative than positive.
- The negative impacts that are mentioned are reductions in cost achieved through personnel cutbacks or the elimination or reduction of functions that could weaken the ability to sell or provide service.

However, a number of users report that there are issues in their companies concerned with improvement in service and product quality, and integration or interconnection of manufacturing functions and work units.

- These issues are having a positive impact on their activities, according to IS users, enabling them to obtain resources and initiate steps that can improve earnings.
- Some users are also responding to issues that generally have a negative impact on funding, such as the recession or restructuring, by asking for funds to improve performance in sales or other functions.

EXHIBIT II-1

Issues Impacting IS Users

Issue	Magnitude of Impact	Effect on Spending Plans
Recession Impact on Sales	4.4	Negative
Restructuring or Cost Reductions	4.2	More Negative than Positive
Foreign and Domestic Competition	4.0	Mixed
Improvement of Service and Quality	3.9	Positive
Integration of Manufacturing Functions	3.9	Positive
Defense Reductions	2.9	Negative
Mergers/Consolidations	2.8	More Negative than Positive

Rating: 5 = high, 1 = low.

The issues listed in Exhibit II-1 that can impact IS users have a stronger impact in some manufacturing submarkets than in others, as shown in Exhibit II-2.

- Most of these issues have more impact on the automotive submarket than on others, as shown by the number of high-ranking issues in this submarket. It is a market area where new technology is being introduced to integrate functions and connect work units as well as to improve service and products. There are also significant factors that inhibit expenditures in this market such as continuing depressed sales and foreign competition.

- The electronic submarket and portions of the "other" submarket including apparel manufacturing also have a number of issues that are ranked at higher levels of impact.

- Of interest, one of the issues that has a relatively high positive impact across submarkets is integration or interconnection of functions and units. This is one of the chief reasons why client/server technology is expanding rapidly in manufacturing.

EXHIBIT II-2

Issues in Relation to Submarkets

Issue	Automotive	Aerospace	Electronic Products	Medical/ Instrument	Mfg. and Other
Recession Impact on Sales	5.0	4.2	4.1	3.2	4.5
Restructuring or Cost Reductions	4.7	4.5	4.2	3.5	3.8
Foreign and Domestic Competition	4.8	3.5	4.4	3.2	3.6
Improvement of Service and Quality	4.3	3.0	4.3	4.2	3.6
Integration of Manufacturing Functions	4.5	4.1	4.1	3.0	3.7
Defense Reductions	2.5	4.9	3.7	2.0	2.3
Mergers/ Consolidations	3.0	3.0	3.0	2.5	2.4

Rating: 5 = high, 1 = low.

C

Trends

IS users feel that some of the issues just discussed as well as several other factors should really be viewed as business trends that are having an important and ongoing effect on their activities, as illustrated in Exhibit II-3.

- The improvement of productivity might be thought of as an objective more than a trend, but many respondents report that there are ongoing efforts to improve sales and reduce or control costs, which should be seen as a trend to improve productivity.

- Users also report that they feel the integration and interconnection of functions are trends that must be dealt with. Since these activities are increasing, companies must develop plans and standards to accommodate them.

- Some IS users also noted that the integration of automated activities on the factory floor or between the factory floor and business functions or the implementation of CIM should be thought of as a major business objective since it is closely associated with productivity and the ability to react to customer needs.

The above comments demonstrate the existence of a strong link between business and the use of IS in discrete manufacturing. In the 1990s, this business commitment will be a precondition for improved use of information technology.

Among the trends identified by IS users, integration and interconnection were emphasized most in regard to the automotive, aerospace and electronics submarkets, but all submarkets ranked it as important.

EXHIBIT II-3

Trends of Importance Identified by IS Users

Trend	Relative Importance to IS Users
Improving Productivity	4.6
More Interconnection	4.4
Integration	3.9
Use of EDI	3.7
Structured Service	3.5
Innovation in Products	3.3

Rating: 5 = high, 1 = low.

As Exhibit II-3 indicates, providing service in a structured form through the use of voice mail or the use of a software product that prompts and monitors contact or other means is another trend reported by users. Introducing or achieving more innovation in products and using EDI more frequently are also trends that users identify from a business perspective.

EDI was mentioned in regard to automotive and electronic submarkets most, and the service and innovation trends were mentioned at about the same level of importance in all submarkets.

D

Key Events

A list of key events was assembled in Exhibit II-4 to illustrate business- and information technology-related activities that are indicative of present conditions as well as new directions, interests and concerns in the discrete manufacturing industry.

- The national concern about foreign competition to the automotive and segments of the electronics and other industries has been marked by the president's visit to Japan as well as by political debates.

- Large cutbacks in personnel at auto manufacturers have emphasized the need to improve productivity.

EXHIBIT II-4

Selected Key Events/Situations

- National concern about foreign competition
- Cutbacks in personnel
- Use of information technology to increase productivity
- Growth of network use to improve operations
- Growth of integration strategies
- Use of outsourcing to reduce costs
- Partnerships between major education institutions and leading manufacturers

New approaches to key industry applications and integrated manufacturing have been taken in the last year.

- A number of organizations including GE, Intel and Motorola have taken initial steps to move much of their computing work to client/server technology to improve productivity, service or quality in operations.

- Downsizing has also been used to increase productivity and/or reduce costs. Deere & Co. speeded up its mainframe MRPII processing through the use of downsizing and client/server technology. A vendor software product was used to achieve that goal.

- Major new networking applications have been installed at manufacturers such as Whirlpool and Caterpillar. Whirlpool has installed a WAN with imaging capabilities and an expert system that can help service agents gain information from product and service manuals so that they can diagnose and solve customer problems more quickly.

- Caterpillar continues to improve its advanced telecommunications satellite capability with the goal of allowing engineers to work simultaneously on the same image of a product from different locations.

- More integration of application systems is taking place in manufacturing. A new approach to CIM that can link manufacturing activities through a parallel processor has been installed at GM. This computing capability not only reduces the number of interconnections that are needed, but handles the processing required in a factory with a significant reduction in cost.

Outsourcing has proved to be of interest in discrete manufacturing, as noted in Exhibit II-4. A major user of computing known for its quality programs for IS, General Dynamics, announced that it would outsource computing to CSC.

Since there is a feeling that better trained college graduates are needed to make real improvements in manufacturing processes, one set of interesting events that has taken place, as noted in Exhibit II-4, has been the organization of special training programs at major universities such as MIT, Penn State, Northwestern, Cornell and Purdue.

- These programs produce trainees that have both engineering and business administration skills and who have the advantage of targeted internships in many cases.

- Major corporations that have helped to finance these programs have reported success from them.

Universities are also involved in other steps to aid manufacturing, such as the effort to evolve a strategic plan for U.S. industry that was carried out at Lehigh in 1991.

III

Information Systems Environment

A

Driving Forces

Although the financial environment does not appear to favor increases in budgets in discrete manufacturing, there are driving forces in business that currently are having an impact on IS budgets, as shown in Exhibit III-1.

- These forces were reported by IS managers and users and ranked in relation to all discrete submarkets.
- The submarkets that respondents felt were most impacted are also indicated in Exhibit III-1.

The highest ranking drivers are concerned with improving service, facilitating sales and decreasing costs, according to respondents.

- Although quality is an overriding consideration and ranks very high, it is not the leading force.
- Some industry experts feel that considerations of quality should be integrated with other goals when planning responses.

EXHIBIT III-1

Current Driving Forces IS Budgets

Driving Force	Relative Importance to Respondents	Submarkets Emphasized by Respondents
Aiding Sales	4.9	All
Improving Service	4.7	Automotive Electronic
Decreasing Cost	4.2	Automotive Aerospace
Improving Quality	3.9	Automotive Electronic
Providing More Internal/External Connections	3.9	Automotive Electronic
Empowering Users	3.8	All
Adding to Product Revenues	3.6	Medical/Instrument Other

Rating: 5 = high, 1 = low.

According to IS managers and users, the highest ranking forces are helping to fuel the growth of technology that can interconnect sales and customer service functions and even customer locations to supply information about problems, product availability, specifications and features. The specific information technology considerations that these respondents noted in relation to driving forces on IS are shown in Exhibit III-2.

- The use of LANs and client/servers and expanded data management (relational data base capabilities as well as the means to handle data from existing applications) were mentioned in relation to both sales and service.

- The technology mentioned above can be of importance in relation to the driving forces concerned with quality by interconnecting design, manufacturing, quality control, customer service and other functions so that

they can interact during the manufacturing process rather than at the end. A number of other steps can be taken in relation to quality, of course.

EXHIBIT III-2

Relation of Driving Forces to Information Technologies

Driving Forces	Information Technology
Aiding Sales	• LAN and client/server • Expanded data management
Improving Service	• LAN and client/server • Expanded data management • Downsizing
Decreasing Cost	• Downsizing, outsourcing, vendor products • Integrating functions • Upgraded applications • Connections for EDI or JIT
Improving Quality	• LAN and client/server • Upgraded applications • Integration
Empowering Users	• LAN and client/server • Downsizing
Adding to Product Revenues	• LAN and client/server • Upgraded applications • Outsourcing
Providing More Interconnections	• Networks • LAN and WAN • Integrated applications • CIM

The driving force concerned with empowering users can be served by client/server technology and downsizing. Access to central data and the distribution of functions can enable users to play a greater role in planning, integrating and even segmenting the use of information systems to achieve manufacturing goals.

The drive to reduce costs can have a number of impacts on IS budgets because it has a number of information technology implications.

- It has resulted in plans and actions to reduce central IS capabilities, downsize application systems, implement EDI and JIT systems, interconnect functions so as to reduce redundant files and activities, and use tested vendor software products instead of in-house development.

- It is encouraging the outsourcing of IS functions such as systems operations, application management, development and maintenance to vendors.

- It has also resulted in demands for more technical expertise to implement, for example, the networks and central relational data management capabilities that can reduce redundant files and activities.

Technical expertise is particularly necessary to support the drive to provide more internal and external connections between related functions including those of suppliers who might be supplying parts and material on a JIT basis or customers who are accessing information on products or using EDI to order and pay for purchases.

- The need for expertise is extremely broad—it must address communications carriers and facilities, network equipment, communication software products, existing conventions and standards, the application systems being interfaced and the services of many types of vendors.

- Need for network technology also raises interest in expenditures for open systems products.

As shown, the driving forces that have been discussed in relation to budgets have strong implications in terms of the use of technology, particularly client/server technology, network capabilities and downsizing.

B

Information Systems Spending

The slowdown that began in discrete manufacturing in the third or fourth quarter of 1990 is continuing, and has had an impact on planning for 1992 information systems budgets, although there are pressures to increase these budgets as discussed in the previous section.

- As a consequence, there is a wide range of budget changes planned for information systems in 1992 versus 1991 among companies interviewed for this study, ranging from an 18% increase to a 10% decrease in budget.

- The average change being planned is reported to be an increase of about 3%.

- This increase could easily be modified, depending on changes in business conditions caused by the budget pressures. User budgets would also be a source of funds in a number of instances, according to IS managers and users.

- The average change is held down by the relatively smaller percentage increases being planned by some firms in the automotive and aerospace submarkets. On a percentage basis, increases being planned in information systems budgets are larger in medical/instruments and other submarkets (see the submarket categories in Chapter I).

There are also pressures for changes in spending from established 1992 budgets being made by executive or user management that is interested in having IS expenditures made in support of departmental objectives rather than for general purposes, as shown in Exhibit III-3.

- These users are particularly interested in promoting the use of client/server and LAN technology, downsizing and/or integration.

- Increased budgets are also being sought for user software purchases and aid in customizing software products or using network capabilities.

- As noted before, there is a strong link between business planning and ideas for the future use of IT technology.

IS users are also interested in holding down areas of the IS budget that are not directly supportive of departmental plans, as shown in Exhibit III-3.

- There are pressures reported to reduce mainframe and data center budgets.

- There is also pressure, as shown in Exhibit III-3, to reduce or delay spending for long-term IS projects.

EXHIBIT III-3

User Attitudes Toward Planned IS Spending for 1992

Desired Changes Reported by Users

- Reduction in central mainframe/data center spending
- Increase in user equipment spending
- Increase in spending for interconnectivity and networks
- Increases in spending for applications software product purchases by departments
- Increases in spending for aid with networks and customization of software products
- Reduction or delay of spending for long-term IS projects

Users are apprehensive about large, centrally controlled projects, but they do support changes in major systems in which they can be involved in restructuring or shaping to meet their needs.

Some IS managers and users felt that budget changes and pressures for further changes reflected shifts that were taking place in their budgets over a period of time.

- An increasing shift or increase in expenditures has been taking place recently to restructure and even to downsize functions of major manufacturing systems, including MRPII and factory floor systems in order to support more flexible manufacturing.
- A shift or increasing growth of expenditures for network applications, including client/servers, is felt to be taking place to support sales and service functions.
- Items such as CAD/CAM that are of importance are not generating a high shift in the use of information systems budgets since the present level of investment is already significant and budgets for them are often in user areas.

- A shift of decreasing expenditures is taking place for centralized capabilities in some companies to improve productivity and reduce central IS costs.

The pressures and shifts in expenditures emphasize several major issues that IS reports it is facing, as illustrated in Exhibit III-4.

- A high-ranking issue is the lack of an overall plan for interconnecting and integrating automated functions in manufacturing facilities in many discrete manufacturers.
- There is also a lack of overall application strategies. Some discrete manufacturers have interfaced supplementary systems to existing MRPII systems to speed up their operation, or have started to test radically different approaches to MRPII without developing a plan for follow-up activities.

EXHIBIT III-4

Major IS Issues

Issue	Relative Importance
Lack of Sufficient Interconnection/Integration Planning	4.6
Overall IS Application Development/Upgrade Strategy	4.2
Ability to Reduce IS Costs	4.0
Role of IS	3.5

Rating: 5 = high, 1 = low.

An IS issue at a number of companies is how to reduce IS costs.

- Additional expenditures may have to be made to maintain existing systems, while efforts are also made to downsize functions from them or to upgrade or replace them to save costs.
- There are driving forces encouraging the use of more technology that can only add to IS expenditures.

One result of this is that IS managers as well as users at a number of large discrete manufacturers are investigating outsourcing steps that might utilize a vendor's experience and capabilities to achieve objectives in a manner that reduces IS expenditures.

- Outsourcing could involve the entire IS budget, as was the case when CSC negotiated a contract with General Dynamics.
- Outsourcing could involve management of a network, or the development and maintenance and/or operation of application systems.

If large contracts are negotiated with SO or SI vendors, IS might continue to run a central installation and act as the coordinator or consultant on the vendor activities. Apart from major changes such as those noted above, there are issues about the role of IS in many discrete manufacturers, noted in Exhibit III-4.

- Over a period of time, the decision-making power of IS in relation to application systems has been shared more and more with user groups, according to both user and IS respondents.
- It has also been reported that outside vendors have taken a larger role in technical expertise and knowledge of industries and applications.

The role of IS in discrete manufacturing is shifting toward that of administrator, facilitator and advisor, while the roles of users and vendors become more significant, as shown in Exhibit III-5.

- In the past, the monopoly of IS knowledge, combined with a centralized approach to the use of IS and the complexity of hardware and software used in discrete manufacturing, supported a reliance on IS executives and organizations.
- Users described their needs, justified projects when called upon and accepted systems.
- Vendors were called upon by IS to supply software products and personnel to aid with systems work.

The change in this paradigm occurred as users learned more about IS equipment through college and work experience. They were also forced to learn more about the use of IS in order to improve the productivity of their functions.

Advances in technology and in vendor capabilities aided in this change.

- Technology that allowed users improve their department and local functions began to focus attention on the contribution that users could

make. Advancements that made equipment and software products easier to use expanded the impact that users could make.

- Vendors found that the increasing amount of knowledge they have gained of industries and applications could be of great advantage to users. They found that their expertise and capabilities could be sold more easily to users when combined with functional knowledge of the business.

EXHIBIT III-5

Shifting IS Role

Former Roles	Evolving Role
IS Role • Needs description • Specific development alternatives • Development, implementation • IS operation • HW, SW, telecommunications expertise • High-level consulting	IS Role • Needs recording • Assistance with specifications justifications and problems • Possible supplier or contractor • Possible operator • Documentation and administration
User Role • Needs survey • Justification • Acceptance • Possible operator	User Role • Needs development • Decisions on suppliers, contractors • Possible contractor
Vendor Role • Supplier	Vendor Role • Technical expertise • High-level consulting • Possible contractor/supplier • Operator

The result has been that users have emerged as the driving force in the use of IS, and the IS department is becoming more occupied with the necessary functions of recording, documenting, keeping track of activities and standards, and administering the processes concerned with planning and using information systems.

Vendors are more able to bring their capabilities to the attention of users and executive management.

- Vendors are expected to be a source of knowledge about how automation should proceed.
- IS may be a part or the leader of a team that includes vendors, or it may be an advisor, team member or documenter for a user that is having a vendor handle a project.

C

Impact of Newer Technology

Apart from the business forces affecting information systems in the discrete industry sector and the shifts being made in budgets as the result of business and user pressures, there are technological factors impacting the IS environment.

- In some companies, the IS staff has been involved and/or the IS budget has supported robotics in warehouse and factory floor automation and the use of new bar coding technology in material movement, inventory management and product delivery.
- IS has also felt an increasing technological impact from requests to interface to the networks and applications of suppliers and customers.

Trends in the use of technology that have had major impacts on the IS environment according to IS managers and user respondents are listed in Exhibit III-6. The ranking emphasizes the impact of client/server use or cooperative processing, as several respondents referred to it.

- One of the reasons for interest in this type of use is that it provides the means for integrating separate functions that are using redundant data. Design or customer service groups can access files of product specifications and information used by manufacturing systems for use in their own work rather than maintain separate files.
- An important second reason is that client/server applications can provide means of modifying or improving the performance of major manufacturing systems without rewriting them. Several large manufacturers report that they are using client/server systems to access and use data on main-

frame MRPII application systems as well as to take over segments of work.

EXHIBIT III-6

Major Technological Trends

Trend	Relative Importance Reported
• Client/Server Use	4.4
• Downsizing	3.9
• Use of Upgraded and Integrated Systems	3.8
• Use of Open Systems/UNIX	3.8
• Network Applications and EDI	3.7
• Image Processing	3.2
• New CAD/CAM Capabilities	3.0

Rating: 5 = high, 1 = low.

The use of client/server technology is raising many challenges, however.

- It can add to the technical knowledge required by users, although users are more likely to learn about IS technology when it is being used in their local functions. Vendors also provide software products with graphical interfaces and other aids as well as professional services aid that can expedite the learning process.

- However, the use of client/server technology can raise questions about the integration of activities or functions split among client/servers and other computing capabilities, overall strategies for upgrading manufacturing, and architectures to be considered in automation plans.

- It can also raise issues about the need for standards and the use of open systems to communicate among equipment.

Together with the use of client/server technology, downsizing and other technology, the use of open systems and UNIX is one of the major technological trends reported in Exhibit III-6.

- Respondents mentioned that the goals of interoperability and portability are being addressed in many environments by obtaining workstations that use a UNIX operating system, and software products, including data bases and application products, that can be used with UNIX.

- Multiple versions of UNIX are in use, however, and other approaches are also being used or suggested for open systems, such as OS/2, versions of DOS, and the CIM/400 product of IBM.

- Other approaches to open systems could also be developed that are better suited to discrete manufacturing or manufacturing as a whole.

- IS departments in the discrete industry must maintain awareness of alternatives and also become involved with UNIX and any other approaches to open systems that user groups in their companies consider or start using.

Open systems is much more than UNIX, and a full strategy is required. It cannot be a casual approach if long-term use and integration are planned.

The use of upgraded and/or integrated manufacturing systems, including CIM (whether partial or full), is reported as a technological trend at a number of discrete manufacturers.

- GM is developing an integrated scheduling system that will replace 30 separate scheduling systems.

- Deere is upgrading the operation of its MRPII system with a client/server-based planning system that will speed up its operation.

A number of manufacturers are considering or beginning to upgrade their manufacturing systems so that they can use relational data bases or data servers that will permit integration with or interfaces to more application areas within companies.

- Vendors are responding to the need for expanded interfaces by upgrading their manufacturing software products so that they can use a common relational data management capability.

- Some vendors and companies are referring to this capability as enterprise resource planning, because it provides a wider view of the organization that includes MRPII, plant floor scheduling, quality management, sales and order management and other functions.

The use of open systems, particularly UNIX, and graphical user interfaces is being promoted for this capability, although the approaches of individual vendors may not be fully compatible. There are also proprietary approaches to this goal being taken by IBM and other vendors.

The manufacturing system that has just been introduced by Oracle will interface to 19 application areas, including business, engineering and shop floor areas. ASK will have competitive capabilities under the name Advance in the near future.

The basic goal of integrating systems, particularly CIM, has been questioned by recent studies.

- Although there are benefits, the payoff has not recovered investments at many companies.
- The involvement of users in more functional areas and their participation in automated systems through client/server capabilities may be needed, as well as more comprehensive planning.

Downsizing is also mentioned as a technological trend because there is interest in distributing capabilities to areas that can manage them better, and in reducing mainframe and data center expenditures by IS users and corporate management.

- Downsizing of segments of application systems have been reported by Intel, Motorola, GE and other manufacturers recently.
- The use of a moderately priced parallel processor rather than a mainframe to interconnect manufacturing functions at GM could also qualify as a step toward downsizing.

The expansion of network applications, particularly EDI, was mentioned as a trend by a number of respondents. The use of EDI has grown in importance as many companies recognize it can improve service as well as save costs.

The use of image processing is another trend that is recognized in discrete manufacturing.

- Integration of image and data processing has been introduced in regard to product and engineering documentation in a number of companies.
- Image processing has also been introduced to aid customer service and marketing.

The use of CASE and CASE tools was also mentioned as a technology of interest, but it remains uncertain whether its use is a true long-term trend.

IV

Information Services Market

This chapter, which will discuss the discrete manufacturing market in detail, is divided into the following sections:

- Market Overview
- Environmental Factors
- Expenditures by Delivery Mode
- Expenditures by Island of Automation
- Vendor Analysis

A

Market Overview

1. Introduction

As a whole, the manufacturing market is larger than all other sectors of the U.S. information services industry. By itself, discrete manufacturing ranks just behind banking and finance, in second place in the U.S. economy.

Manufacturing covers the production of a wide range of products, from space vehicles to clothes, jewelry and petroleum products. The manufacturing market is divided into two sectors, discrete and process, on the basis of the goods produced. The subsectors of discrete manufacturing and process manufacturing are listed in Exhibit IV-1.

INPUT's definition of discrete and process manufacturing conforms closely with the U.S. Standard Industrial Classification (SIC) system. The only exception is petroleum, which the SIC manual classifies as an extractive industry and which INPUT considers part of process manufacturing.

EXHIBIT IV-1

Manufacturing Industry Structure

- Manufacturing
  - Discrete
    - Apparel
    - Furniture
    - Printing
    - Leather
    - Metal
    - Machinery
    - Electronics
    - Autos/Trucks/Buses
    - Aircraft
    - Scientific & Control Instruments
    - Miscellaneous
      - Jewelry
      - Toys
      - Pens & Pencils
      - Buttons & Pins
      - Signs
      - Caskets
      - Floor Covering
  - Process
    - Mining
    - Oil & Gas
    - Food Products
    - Tobacco
    - Textiles
    - Lumber/Wood Products
    - Paper
    - Chemicals
    - Petroleum
    - Rubber & Plastics
    - Stone, Glass, Clay
    - Primary Metals

2. Market Structure

The discrete market can be analyzed by dividing it into product groups such as durables, nondurables, information products and style goods. INPUT has tentatively divided the market into six submarkets in order to analyze the use of information systems further:

- Automotive
- Aerospace
- Machinery/metal
- Electronic/radio
- Medical/instrument
- Other

The components of discrete manufacturing previously discussed can be assigned to these submarkets, as shown in Exhibit IV-2.

EXHIBIT IV-2

Discrete Manufacturing Submarket Components

Market Segment	Components
Automotive	Automotive, truck, bus, train
Aerospace	Airplane, space, missiles
Manufacturing/Metal	Machinery, metal products
Electronics	Electronics, radio detection
Medical/Instruments	Medical equipment, dental equipment, laboratory instruments
Other	Apparel, furniture, leather, jewelry, toys, sporting goods, printing, publishing, all else

These submarkets differ from each other to some extent in the factors that drive their use of information systems.

- Defense contracts and the reporting that they require, as well as the complexity of manufacture, have been significant factors in the use of information systems in the aerospace industry.

- The automotive market has been driven by pressure from foreign competition as well as by the recession's effect on buying.

Although there are exceptions, the first three submarkets have generally implemented the most advanced information technology applications, although some companies in the printing and publishing business have been involved in new developments, including Dow Jones & Company, Knight-Ridder and several leading magazine publishers. Dow Jones installed satellite-based information transmission systems in the early 1980s.

3. Market Segmentation

The discrete and process manufacturing sectors and the discrete submarkets can be further segmented into key applications areas, or islands of automation:

- Business
- Engineering/design
- Factory floor

These areas and overall system environments that address them will be discussed in more detail in Section D of this chapter.

B

Environmental Factors

1. Driving Forces

The forces that information services vendors report as driving their activities and growth in the discrete market are shown in Exhibit IV-3.

- These forces correlate in general to the forces that users reported, discussed in the last chapter, except that users gave slightly more emphasis to service, sales support and cost reduction.

- Vendors who responded to the issue tended to associate these forces with all submarkets of discrete manufacturing, but felt that the first three forces had more of an impact on the automotive and electronic submarkets.

Vendors note that domestic car manufacturers, particularly the three major car makers, are all pursuing plans to upgrade systems to improve service and quality, driven by overseas as well as domestic competition.

- Domestic competition now includes the activities of transplants such as Toyota, which is investing strongly in information systems in order to increase service and quality.

- A number of other companies, such as The Stanley Works, have also invested in application systems to improve quality. Stanley's investments in warehouse management, MRPII, sales management and EDI systems have all been associated with the objective of improving quality.

Not all companies or subsectors, however, are investing at a high level in IS in order to improve quality, as noted by a recent study in which Ernst & Young participated.

EXHIBIT IV-3

Forces Driving IS Strategies of Vendors Serving Discrete Manufacturing

Force	Level of Importance
• Improve Services	4.6
• Reduce Costs	4.4
• Improve Quality	4.1
• Provide Users with Connectivity/Processing	4.0
• Upgrade/Integrate Application Systems	3.9
• Interconnection to Clients and Suppliers	3.7

Rating: 5 = high, 1 = low.

Vendors also recognize that the drive to reduce costs is strong in many companies across all submarkets that have been discussed. One reason for this is the debt burden that companies have been carrying.

- One of the objectives of the recent outsourcing contract at Subaru America was reported to be cost savings.
- An objective of the downsizing program at GE Nuclear is to save on future costs as well as provide a means of having users more involved in work functions.

Vendors of information services are very responsive to the need for more connection with internal and external entities in discrete manufacturing, and believe that this is driving the use of their services.

- Providing users with more capabilities for improving their operations by accessing and manipulating data in other automated functions is occurring throughout discrete manufacturing.
- Being able to supply and obtain data to and from suppliers and customers can also drive user expenditures for information services to improve performance and service as well as reduce costs, vendors report.

The forces just reviewed encourage the consideration of certain technologies, according to information services vendors. The technological considerations mentioned most frequently include:

- Integration of applications, data bases and networks
- Network, LAN and client/server use
- Relational data bases, and the capability to handle expanded application systems
- Downsizing
- Open systems and/or standards

Information services vendors and users are not far apart regarding the factors of importance to users in selecting information services vendors, shown in Exhibit IV-4.

- Users emphasize industry and application knowledge more than some vendors appreciate, however.
- Users also stress project management to a greater extent and certain technological skills less than some vendors do.

EXHIBIT IV-4

Selected Evaluation Factors for Information Services Vendors in Discrete Manufacturing

Factor	Average Rating by Users	Average Rating by Vendors
Industry Knowledge	4.9	4.3
Application Knowledge	4.6	4.3
Reputation	4.6	4.4
Technical Expertise	4.2	4.6
Similar Experience	4.1	4.0
Project Management Skills and Methodology	4.1	3.5
Use of UNIX, CASE, AI, or Other Technologies	2.7	3.2

2. Growth Inhibitors

Exhibit IV-5 identifies the key inhibitors to growth in information services expenditures identified by vendors.

Reduced and limited budgets due to economic conditions is an inhibiting factor at many companies, according to vendors.

- This does not mean that all spending is curtailed, but limitations on what can be done must certainly be considered.
- This factor can encourage the use of client/server solutions and downsizing rather than mainframe solutions, because less cost will probably be involved. However, the question of whether these solutions are the best alternative or are carried out in relation to strategic business application planning or architectural plans for technology use may not be considered in view of cost constraints.

Lack of interconnection between different functions as well as between islands of automation, such as the factory floor and business units, can be an inhibiting factor to the products and services of some vendors, although others regard it as an opportunity.

The lack of an overall plan for achieving an integrated environment through information technology can inhibit development work but can provide an opportunity for some information services vendors.

Lack of specific technical expertise can also be a difficulty at times and is one reason a number of vendors have developed alliances with each other.

The involvement of more parties in decision making can also be an inhibiting factor for vendors, as noted in Exhibit IV-5.

- Increasingly, major IS purchase decisions are moving away from the chief information officer (CIO).
- User committee members are often more important as decision makers. However, as committees include more users, organizations may find it difficult to move rapidly.

Information services vendors may need strategies to speed up decisions. These may include demonstrations of working solutions, as used by Andersen, prototypes of manufacturing operations such as those used by Computer Associates, or the ability and experience to walk through functions practiced by a number of vendors, to bring matters to a decision.

The strategies mentioned above can also aid in relation to another inhibitor: the growing need to acquire solutions to ever more complex system requirements. As needs become more complex, more users can become involved and find it necessary to visualize solutions with more clarity.

EXHIBIT IV-5

Growth Inhibitors to Information Services Use

Inhibitor	Degree of Importance to Vendor Respondents
• Reduced/Limited Budgets	4.9
• Lack of Interconnection between Functions	3.7
• Lack of Overall Planning	3.4
• Involvement of More Parties in Decision Making	3.2
• Lack of Technical Expertise	2.4

Rating: 5 = high, 1 = low.

C

Expenditures by Delivery Mode

1. Overall Expenditures

As shown in Exhibit IV-6, 1992 user expenditures for information services in discrete manufacturing will reach $13.1 billion, an increase of 12% from 1991 user expenditures of $11.9 billion.

- Between 1992 and 1997, it is projected that user expenditures will continue to increase at a compound annual rate of 12%, reaching $22.9 billion in 1997.

- Among all industry sectors tracked by INPUT, discrete manufacturing is in second place, close behind banking and finance. Discrete constitutes more than 25% of the expenditures among the top five industry sectors.

EXHIBIT IV-6

Discrete Manufacturing
Total User Expenditures, 1992-1997

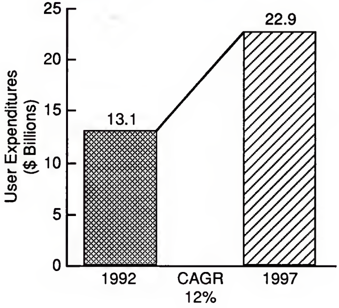
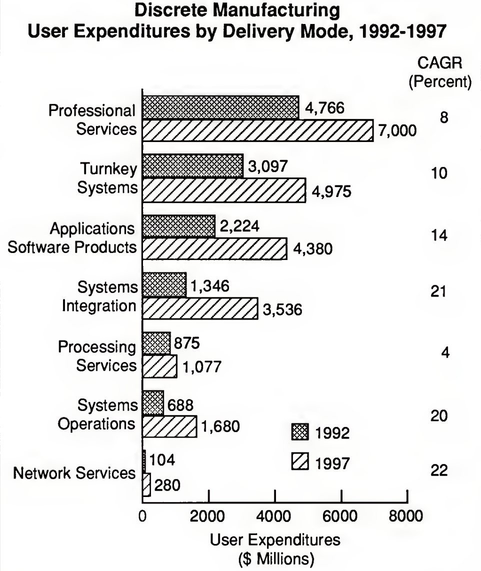


Exhibit IV-7 divides the discrete manufacturing sector into INPUT's seven delivery modes.

EXHIBIT IV-7



2. Professional Services

Professional services has the largest amount of user expenditures among modes of service in discrete manufacturing, and will maintain that lead in 1997 when it will amount to $7.0 billion. However, it is one of the slower growing modes, at an 8% CAGR.

- Professional services includes software development and enhancement work performed by a large number of vendors of various sizes, consulting work performed by a smaller number of sizable vendors in most cases, and education and training work performed by a small number of vendors that includes both very large and very small vendors.

- Consulting work is the fastest growing submode of professional services, increasing at a CAGR of 14% through 1997 and driven by the need for strategic and information technology planning.

- Systems development is still the largest submode of professional services, although it is growing at a low CAGR of 5%. This is due to some extent to the fast growing use of systems integration as a development alternative, as well as greater use of applications software products, particularly for workstations, to meet systems needs.

- Professional services work often relates to specific application systems. Application development and maintenance is carried out as part of systems development work, and application management activities are carried out as part of consulting services.

Discrete manufacturing remains a major factor in the professional services market. At $4.8 billion in 1992, it represents over 25% of the total professional services business, which explains why so many large vendors in the business offer services to the discrete industry.

3. Applications Software Products and Turnkey Systems

The discrete manufacturing sector is a good target market for applications software vendors.

- The use of applications software products will grow at a CAGR of 14% as shown in Exhibit IV-8, driven by a CAGR of 24% for workstation/PC products.

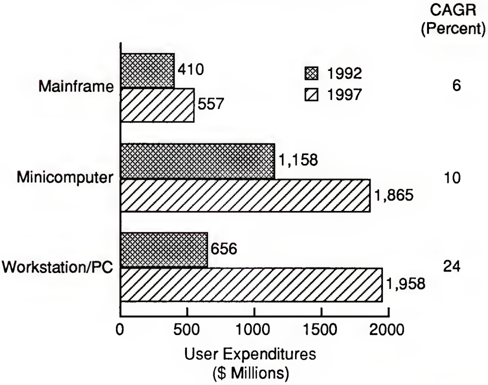
- In the applications software area, users spend more for minicomputer-based software products than for mainframe- or workstation/PC-based software products combined. However, Exhibit IV-8 indicates a changing pattern of user expenditures; organizations will purchase significantly more applications software products running on workstations/PCs by 1997.

In turnkey applications, the advance of the workstation/PC has been even more pronounced, but it was mitigated in the applications software products categories by the continued utility of the minicomputer in some applications, such as production control and factory floor.

- The use of workstations in client/server applications has changed the picture significantly and is helping to fuel the rapid growth of applications software products for workstations.
- The expanding use of workstations in engineering and CAD/CAM applications is also of interest in discrete manufacturing, but not all expenditures for these applications are included in industry totals, because they are cross industry in nature.

EXHIBIT IV-8

Discrete Manufacturing Applications Software Products Expenditures by Platform Size, 1992-1997



U.S. Census Bureau statistics from recent years suggest that sales of applications software products may be higher in the automobile, electronics/instruments, and aerospace submarkets than in machinery and other markets.

INPUT believes that large manufacturing companies will increase spending for applications software products relative to medium and small company spending because of the greater relative magnitude and complexity of their operations.

- Although there are about 70 times as many small manufacturing companies as large ones, they do not add up to a meaningful fraction of the opportunity that larger companies provide.

- Smaller companies have not advanced as far in automation, generally, as larger discrete manufacturers, but they do offer opportunities for turnkey and software product solutions.

4. Systems Integration

Growing at a CAGR of 21% through 1997, when it will reach a level of nearly $3.6 billion, SI offers a significant opportunity in the discrete manufacturing industry.

- By 1997, the annual increase of SI business will be greater than the corresponding increases of professional services or applications software product businesses.

- SI also presents an opportunity to secure a contract for a longer period of time. Large and fast growing vendors such as Andersen Consulting, EDS and CSC have capitalized on SI business in the discrete manufacturing industry, where companies are seeking the aid in industry and application knowledge that these vendors have prepared themselves to provide.

5. Processing Services and Systems Operations

In 1997, transaction processing services in discrete manufacturing will be a $1.1 billion market, but it is growing at the low CAGR of 4%. Reasons for large transaction processing expenditures include:

- The use of supercomputer networks for sophisticated engineering and design processing

- The use of processing services with large networks to handle processing for scattered locations and customized backup and disaster recovery facilities

Systems operations, for which expenditures are smaller than for processing services at this time, is growing at a much higher CAGR and will surpass processing in volume in 1994.

- The systems operations CAGR from 1992 to 1997 is forecast to be 20%, which will result in $1.7 billion of user expenditures in 1997.

- The SO mode of service provides the means for users to obtain the expertise and economies of scale that large vendors can provide in the operation of their equipment or in the management of their application systems without making large investments.

6. Network Services

Although the components of network services are growing rapidly in discrete manufacturing, the total market will amount to only $280 million in 1997.

- Electronic data interchange (EDI) has been a major influence upon the size and the CAGR of 24% for network applications in discrete manufacturing. EDI applications will increase by about 50% during the forecast period.

- Expenditures for electronic information services will also grow at a high CAGR of 20% between 1992 and 1997.

D

Expenditures by Islands of Automation

This section will evaluate user expenditures based on INPUT's model of islands of automation:

- Business
- Engineering/design
- Factory floor

Key application systems within business include manufacturing resource planning (MRPII), material requirements planning (MRP), and inventory management. Engineering includes computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM) applications. Factory floor encompasses shop floor control, numerical control machine products, and robotics.

- Business and engineering/design applications together account for about 80% of user expenditures in discrete manufacturing. The use of all CAD applications is not included, because many are cross industry in nature.

- INPUT's user expenditure sizing of the factory floor application includes computer-aided manufacturing, numerical control, process control, and shop floor control. INPUT's definition excludes metalworking equipment, programmable controllers, automatic inspection systems, and material-handling systems.

User expenditures have varied widely by application system and submarket within each island of automation.

- For example, the MRP application has been widely implemented in aerospace and automotive, but is used less in electronics.

- MRPII, with higher average selling prices than MRP applications, accounts for significant revenue in the business island of automation, particularly in the automotive industry.

- Within the engineering/design island of automation, electrical engineering/electronic design products and services account for most user expenditures, followed by computer-aided design (CAD) and mechanical engineering products and services. These products and services have penetrated the aerospace and automotive industries most.

Historically, discrete manufacturing has had a relatively large installed base of order entry, purchasing, and inventory management software products.

- More than ten years ago, when minicomputers showed the greatest cost effectiveness in financial applications, software and turnkey vendors seized that opportunity.

- Engineering/design applications were developed primarily in-house, although software and turnkey products have been introduced widely for that purpose in recent years.

- Factory floor applications were also originally developed in-house in the past, due partially to the lack of standards.

Historical opportunities for software products vendors most likely led them to concentrate resources in the financial area.

- Recently, software and services vendors have expanded further into the other islands as well as into approaches for integrating application systems and achieving CIM.

- Most of these approaches have only succeeded in partially linking the three islands of automation.

E

Vendor Analysis

Analysis of vendor revenue reveals that the combined market share of the top ten vendors from 1985 through 1992 has dropped from 18% to about 12% during this period, as shown in Exhibit IV-9.

- Allowance must be made for the fact that much of the revenue from GM is no longer counted, since it is captive, and some categories of applications are not counted at present because they are cross industry. Total vendor revenue has also increased by more than 213%.

- Despite the allowances mentioned above, the business of the top 10 vendors is over twice as high in dollar terms in 1992.

EXHIBIT IV-9

Discrete Manufacturing Combined Market Share of Top 10 IS Vendors, 1985-1992

	Market Size ($ Billions)	Market Share (Percent)
1985	6.2	18
1992	13.1	12

The division of user expenditures by vendor categories has been changing.

- Computer manufacturers have increased their share of the discrete business by providing more professional services, software products and turnkey systems than was previously the case. Also, manufacturers have been very active in providing the newer, fast growing SI and SO business.

- Firms outside of the information services industry—including Big 6 firms such as Andersen Consulting and Coopers & Lybrand as well as companies that have bought information services firms, such as GM—have increased their share of the discrete manufacturing industry.

- Dedicated turnkey vendors have a decreased share of the discrete business because some of them have been bought by computer manufacturers, suffered falling business or have concentrated more on cross-industry business. Also, computer manufacturers and software product and other vendors have all begun to compete for turnkey business.

- Independent software and processing/network services vendors continue to hold shares of the industry business.

V

Competitive Environment

A

Introduction

This chapter presents detailed information on IS vendors serving the discrete manufacturing sector. The chapter is divided into the following sections:

- Leading IS Vendors
- Mergers and Acquisitions
- Vendor Profiles

INPUT conducts extensive analyses of vendor revenues. In order to present useful and accurate information for the discrete manufacturing market, U.S. revenues were subtracted from total revenues, and revenue was split between discrete and process manufacturing sectors in instances where an IS vendor served both sectors.

B

Leading Vendors

Exhibit V-1 presents the market shares of the leading applications software products companies serving the U.S. discrete manufacturing sector.

- This exhibit illustrates that applications software products are produced by companies that are only software vendors as well as by computer vendors and companies in other industries that have acquired software product firms.

- Just as other types of vendors have entered the software products market, many software firms, including ASK, System Software Associates, American Software, Dun & Bradstreet and particularly Computer Associates have added professional services work. Much of this work is involved with customization and enhancement of software products, but some assignments include consulting, training and small development tasks.

EXHIBIT V-1

Leading Applications Software Products Vendors in Discrete Manufacturing*, 1991

Vendor	Market Share (U.S.)
ASK	6
IBM	4
Dun & Bradstreet	4
Cadence	3
Groupe Bull	3
System Software Assoc.	2
Computer Associates	1
American Software	1
Cincom	1

*Most CAD/CAM and other cross-industry not included.

Some CAD and other cross-industry software products are not considered in this list because they are not specific to discrete manufacturing. Vendors such as Cadence that address only specific areas of the discrete manufacturing market are included, but the products of Intergraph and other vendors, including CADAM, are not included since they are cross industry in nature.

Although much of the revenue is cross industry, CAD/CAM is also the leading application product for turnkey systems in discrete manufacturing today, as it has been for over two decades.

- The tightly coupled requirement for CAD applications software and high-performance graphics makes CAD/CAM one of the strongest uses for turnkey systems in discrete manufacturing.
- With the acquisition of CADAM from Lockheed, and the shipment of the RS/6000 in 1990, IBM became a significant factor in this market.

Computer manufacturers have become important in the turnkey delivery mode by obtaining CAD/CAM and other products to sell with their computing equipment.

- Prime acquired CAD/CAM products, just as IBM did.
- Prime has also implemented the Pick operating system to support manufacturing and distribution programs available in the Pick world.

Vendors of turnkey products that have industry-specific solutions for the discrete industry include Prime, ASK, EDS, Hewlett-Packard, SAP and a number of vendors with very small market shares.

Exhibit V-2 presents the market shares of professional services vendors in discrete manufacturing.

- The vendors offering this service are diverse, including Big 6 firms, subsidiaries of aerospace and other industrial firms, computer hardware firms, and vendors devoted to professional services.
- The leading two vendors in this mode are professional services vendors.

Because the professional services market is the largest mode in discrete manufacturing, and there are no vendors with a market share of significant size, it is evident that there are many vendors with small amounts of professional services work.

- Some of the work is being done by firms in other modes, including software products and turnkey systems.
- There are also a number of contract services vendors that operate as agencies that supply personnel for professional services assignments.

EXHIBIT V-2

Leading Professional Services Vendors in Discrete Manufacturing, 1991

Vendor	Market Share (U.S.)
Computer Task Group	2
Analysts International	2
Andersen Consulting	1
IBM	1
EDS	1
Coopers & Lybrand	1
AGS	1
Groupe Bull	1
Hewlett-Packard	1
A.D. Little	1
Computer Sciences	1
CGA	1
NCR	1
Computer Horizons	1
Ernst & Young	1

As shown in Exhibit V-3, the ten leading vendors of systems integration control a larger share of the total market than is the case with professional services (31% versus 12%).

- The SI market is growing much faster and has higher margins of return than professional services in general. It is more likely that vendors will fight for larger shares of this market.

- The SI market is also harder for the agency-type firms to place people in who have been terminated or who are foreign nationals. Knowledge of industries and experience in implementing solutions to complex problems are differentiating features of SI firms.

EXHIBIT V-3

Leading Systems Integration Vendors in Discrete Manufacturing, 1991

Vendor	Market Share (U.S.)
Andersen Consulting	10
CSC	4
IBM	4
DEC	3
Coopers & Lybrand	2
CGA	2
Deloitte Touche	2
EDS	2
CTG	1
KPMG	1
Price Waterhouse	1
TSC	1

Exhibit V-4 presents a list of leading systems operations vendors and market share information.

- The four vendors that lead this list are the largest vendors in the information services industry. These vendors have choices about the modes of service they can offer, in view of their size and penetration of other modes. They have chosen to gain market share in this mode due to the long contracts, add-on work and margins that are involved in systems operations.

- The smaller two vendors listed in V-4 are two of the leading smaller vendors active in this mode, indicating that the opportunities available in systems operations are being taken advantage of by smaller vendors also.

EXHIBIT V-4

Leading Systems Operations Vendors in Discrete Manufacturing, 1991

Vendor	Market Share (U.S.)
EDS	17
CSC	4
IBM	3
Andersen Consulting	2
Genix	<1
Litton	<1

Exhibit V-5 lists selected merger and acquisition activities and alliances occurring among IS vendors serving the discrete manufacturing sector. These alliances illustrate how vendors serving this sector attempt to strengthen their positions.

- EDS has pointed out that its acquisition of the McDonnell Douglas SI company strengthened its position in manufacturing.

- Computer Associates added to its systems software and manufacturing capabilities with the acquisition of Pansophic. CA has already strengthened the marketing of Pansophic manufacturing software products by adding a means of reviewing capabilities and planning installation for the use of prospects.

EXHIBIT V-5

Illustrative Acquisitions, Mergers and Alliances Among Vendors Serving Discrete Manufacturing

Acquirer (or Ally)	Acquired/Merged (or Ally)
Computer Assoc.	Pansophic
EDS	McDonnell Douglas SI Company
Coopers & Lybrand (Ally)	NMI (Ally)

C

Vendor Profiles

Profiles of a number of different types of information services vendors active in the discrete manufacturing industry are presented in this section. The strategies, background, and products and services of these vendors are reviewed to illustrate the range of competition in the industry.

Some vendors active in discrete manufacturing concentrate on a limited set of capabilities in one delivery mode or industry.

- GEIS provides EDI and VAN network applications services to discrete manufacturers and other industries.
- Gerber Scientific provides CAD/CAM turnkeys to companies in a range of discrete manufacturing markets.

Other vendors are focusing on information services products and services that can meet a wider range of needs of prospects.

- Andersen Consulting, Coopers & Lybrand and other Big Six firms are attempting to meet a wide range of needs in a number of areas of discrete manufacturing as well as in other industries.
- Through the acquisition of MDSI, EDS announced that it had strengthened its ability to offer a wide range of services across discrete manufacturing.

The larger vendors serving the discrete manufacturing market also serve a number of other markets, as illustrated by the vendors that have been

mentioned above. There are many small vendors such as Symix and Factorial Systems serving only the discrete manufacturing market or only discrete and process manufacturing customers.

In addition to the companies that are profiled, many other information services vendors serve the discrete manufacturing market, including IBM, NCR, DEC, and GEIS.

Companies that are profiled include:

- Andersen Consulting
- American Software
- ASK Computer Systems
- BT Tymnet
- Computer Task Group
- CACI
- Dun & Bradstreet Software
- Factorial Systems
- Sterling Software, Inc.—EDI Group
- Symix

Additional information about these companies or other companies active in discrete manufacturing can be found in the VAP Program of INPUT

1. Andersen Consulting, Arthur Andersen & Co., 69 West Washington Street, Chicago, IL 60602

a. Company Strategy

Andersen supported its reputation as a leading information services vendor in manufacturing by announcing one of the largest client/server projects thus far undertaken by a vendor, begun in 1992 for a manufacturing client. Andersen utilizes its reputation and demonstrations of working solutions to manufacturing and distribution problems as a means of appealing to and closing business with prospects who are solution oriented. Attention is focused on manufacturing, but is also given to retail and wholesale distribution and to banking, utilities and other markets.

Andersen emphasizes its knowledge of industries and applications to make presentations and conduct consulting studies that can lead to large SI and professional services contracts. In addition to these services, Andersen has sold its manufacturing software products through a VAR.

By studying the performance and problems of companies in its areas of interest, Andersen has been able to suggest opportunities to gain revenues and improve earnings to companies that it contacts. The firm uses acquisitions and alliances to gain knowledge and additional resources that address its areas of interest.

b. Company Background

Andersen Consulting was set up by Arthur Andersen & Co. as a separate firm in 1988 to address its rapidly growing and large volume of information services business. Estimated worldwide revenues in 1991 for Andersen Consulting were $2,650 million, about 25% above the revenue for 1990. U.S. revenues increased by about 9% to $1,345 million in 1990.

c. Key Products and Services

Over half of 1991 revenue was derived from systems integration and about 25% was from professional services. Systems operations revenue was about 8% of revenue in 1991, and revenue was also obtained from applications and systems software products and network services.

Areas of manufacturing expertise include CIM, CAD/CAM, MRPII, robotics, material handling, numerical control, bar code data collection and change management control.

2. American Software, Inc., 470 East Paces Ferry Rd., Atlanta, GA 30305 (404) 261-4381

a. Company Strategy

American Software derives both applications software and professional services revenue from an integrated line of standard applications software products for IBM mainframe and AS/400 platforms. These products were designed to run singly or in combination to meet unique customer requirements.

- These products have been supplemented to meet the needs of installations in cetain industries, particularly manufacturing.

- American Software will perform professional services work to customize its software products to solve customer problems.

In addition to a set of manufacturing modules, American Software can offer a full MRPII system for IBM mainframes and minis.

b. Company Background

American Software was founded in 1970. The company grew to around 750 full-time employees in 1990, and its calendar-year revenues for 1991 were over $100 million, with about $90 million in revenue from the U.S. The company provides both applications software products and professional services to manufacturing, distribution, utilities, banking and finance, health care, education, transportation and government clients.

c. Key Products and Services

About 37% of American Software's revenues are provided by professional services and 13% from maintenance of software products, which could be included as part of professional services.

- As shown above, about half of the company's revenue is from professional services.
- American Software is one of the most successful software vendors in marketing professional services.

The applications software products it sells can be divided into two groups:

- Forecasting and inventory management software that accounts for about 8% of revenue
- Purchasing, materials control and financial software that accounts for about 38% of revenue.

Specific manufacturing modules include master scheduling, materials requirement planning, bill of material, capacity planning, production work status, shop floor control and cost management and tracking.

3. ASK Computer Systems, Inc. 2240 W. El Camino Real, Mountain View, CA 94039-7640 (415) 969-4442

a. Company Strategy

ASK is the largest vendor offering chiefly software products to the manufacturing industry. ASK projects the image of a vendor that understands manufacturing and has a full set of products that can meet needs. It concentrates on offering an on-line, interactive system (the MANMAN Information System) of integrated modules that can meet the needs of many discrete or process manufacturers.

- Modules are available for manufacturing, finance, marketing, customer service, decision support and computer-integrated manufacturing purposes.
- The software products are available in turnkey solutions, software products for HP, IBM, and DEC midrange computers, and on a processing service.

ASK has recently announced its support of Enterprise Resource Planning, an enterprisewide approach to information systems use that facilitates the integration of current and new systems. Building on MRPII core systems, this approach makes it possible to collect and use information from hetero-

geneous environments and promotes the distribution of functions to user areas through client/server technology.

b. Company Background

ASK was incorporated in 1974 to serve the manufacturing industry. Its early acquisitions supported the platforms, software products and clients that it had in manufacturing. Its acquisition of Ingres in 1990 brought in new types of clients and customer problems, although it also brought ASK the resource necessary to address the increasing integration of functions in manufacturing, a relational data base.

Information services revenues in the U.S. are now above $240 million on a calendar-year basis.

c. Key Products and Services

As noted above, ASK has an on-line set of manufacturing software modules that run on mini platforms as well as a relational data base capability. ASK is also developing and will introduce in 1992 an open system set of modules that will facilitate the integration of functions and support the Enterprise Resource Planning approach to business described above.

4. BT Tymnet, Inc. 2560 North First St., San Jose, CA 95131 (408) 922-0250

a. Company Strategy

BT Tymnet is in business to be one of the world's largest providers of a wide range of shared, dedicated and hybrid network solutions. The company operates the TYMNET public packet data communications network and provides access to dial-up services, major on-line data bases, EDI services, card authorization/electronic data capture and other services in support of its strategy.

BT Tymnet has taken actions to penetrate manufacturing, distribution, warehousing and other industries where EDI business could grow.

b. Company Background

The TYMNET data network was initiated in 1969 to support remote processing services to timesharing clients. In 1977, it became an FCC-regulated specialized common carrier, and was acquired by McDonnell Douglas in 1984. In 1989, it was acquired by British Telecom plc together with a value-added service provider active in Japan. These acquisitions—with Dialcom, acquired in 1986—were organized as BT Tymnet, a subsidiary of British Telecom, in 1989.

c. Key Products and Services

The TYMNET network consists of intelligent communications processors and network capabilities that allow clients to communicate between attended or unattended terminals and their own or other computers in a variety of different locations. A number of different protocols, error correction, protocol conversion, data security and other services are provided by the network. Access to major on-line data bases is also provided through this network.

EDI*Net is the principal EDI service of BT Tymnet, providing third-party value-added communications services for automated exchange of business documents such as purchase orders, invoices and bills of lading. There are over 1,000 clients in the transportation, distribution, manufacturing, and telecommunications industries. A significant discrete manufacturing area of use is the aerospace industry, which is a large user of EDI and other network services.

Credit card and electronic data capture are provided for all major credit cards as well as private label programs.

Private and hybrid data networks are also provided to clients in a number of industries. Ford utilizes a hybrid system combining shared and dedicated equipment and VAN services from BY Tymnet.

5. Computer Task Group, Inc., 800 Delaware Avenue, Buffalo, NY 14209 (716) 882-8000

a. Company Strategy

CTG uses its extensive experience with automated manufacturing application systems as well as its knowledge of suppliers, distribution and other manufacturing functions and problems to assure clients of its ability to meet a range of problems from large, complex jobs to tasks requiring the knowledge of high-level technological skills. Capabilities have been developed to support systems integration and network development and integration activities.

CTG can bring its strengths to bear in a number of industries, including discrete and process manufacturing, business services, banking and finance, insurance, and state and local government. CTG has considerable knowledge of the implementation of MRP and MRPII systems.

b. Company Background

Computer Task Group, founded in 1966, is one of the largest vendors of professional services, concentrating on markets other than the federal government. It provides systems integration services as well as professional services. Its U.S. revenues were about $275 million in 1991.

In 1989, IBM made an investment in CTG and has used CTG's systems engineers on work for IBM and its clients.

c. Key Products and Services

Over 80% of 1991 revenue was from professional services, and the balance was made up of systems integration work and a small amount of systems operations work. CTG provides consultants experienced in industry problems as well as in technology, which is attractive in discrete manufacturing.

- CTG's staff can augment the staff of a client and become part of the project team on a specific project, or they can manage and staff an entire project.
- CTG has experience in supporting large clients on a single site or multiple sites, domestically or worldwide.

6. CACI International, Inc., 1700 North Moore St., Arlington, VA 22209 (703) 841-7800

a. Company Strategy

CACI utilizes its strengths in advanced information system development, engineering and logistics systems, and simulation systems and modeling to obtain federal government contracts.

In recent years, CACI has been using the strength it gained through government work to provide inventory and warehouse systems to wholesale, retail, manufacturing, and other commercial businesses.

b. Company Background

CACI was founded in 1962 to provide professional and marketing services based on a high level of technology to U.S. and international markets.

About 70% of CACI's business is with the federal government, and includes program management, policy decision support and advanced systems support.

In addition to utilizing knowledge it has gained in government work to obtain contracts to develop inventory and warehouse systems, CACI has engaged in commercial work in support of marketing analysis and planning.

c. Key Products and Services

CACI's services in wholesale and retail distribution and manufacturing include inventory and warehouse management and warehouse automation.

In addition to consulting and software development, CACI provides implementation work on the robotics used in warehouse automation.

In the federal market, as described above, CACI provides professional and engineering services and simulation and modeling. CACI has one of the leading if not the premier applications software products in use in simulation and modeling of systems, SIMSCRIPT.

Marketing support activities provided on an international basis include market research and demographic consulting.

7. Dun & Bradstreet Software Services, Inc., 550 Cochituate Rd., Framingham, MA 01701

a. Company Strategy

Dun & Bradstreet develops, markets and supports a wide range of industry and cross-industry software products on multiple vendor platforms that provide it the opportunity to market to a number of industries. The company has prepared itself to support the movement from mainframe to mini, workstation and client/server solutions. Application products for use in manufacturing inlude:

- Applications software products are available for financial and accounting, human resources, administrative, purchasing, inventory, manufacturing, education and health industry functions. Many of these products are used in manufacturing, since manufacturing accounts for 45% of company revenues.
- The AMAPS systems support both discrete and process manufacturing environments on multiple vendor platforms. A program is available to develop interfaces with the manufacturing software products of other vendors.

In addition to AMAPS systems, discrete manufacturers use Dun & Bradstreet software products for inventory control, human resources, accounting, financial reporting and other standalone applications. Dun & Bradstreet also provides professional services aid in planning, using and customizing software products.

D&B's software products utilize a number of hardware platforms, including IBM, Unisys, DEC, HP and Bull mainframe and midrange equipment.

b. Company Background

This company is a subsidiary of the Dun & Bradstreet Corporation. It was formed in 1990 as a result of the merger of Management Science America, which was acquired in 1990, and McCormack & Dodge, acquired in 1983.

The former had been founded in 1963 and had over 24,500 product installations. The latter, founded in 1969, had over 10,000 product installations.

c. Key Products and Services

This vendor's software addresses a number of functions, as described in the following:

- The Millennium Series supports human resource, accounting and support functions, chiefly on IBM and compatible mainframes, but some products are also available for DEC VAX computers.
- The PLUS series offers accounting and a micro-to-mini link for IBM AS/400s and System /38s.
- Human resources products are available for IBM and compatible PCs.
- The BrightView Series, which allows the use of intelligent workstations and addresses accounting, inventory and budgeting functions, uses IBM mainframe and 9370 computers.
- The AMAPS manufacturing software products, which also can use intelligent workstations, are available for IBM mainframes and minis and HP computers.
- Software products are also available for education, factory operations and other functions.

8. Factorial Systems, Inc., 6300 Bridgepoint Parkway, Austin, TX 78730 (512) 345-1192

a. Company Strategy

Factorial was founded to provide manufacturing control systems solutions. The capabilities it is using to achieve this objective include:

- The expertise and experience of its employees in implementing factory management and control solutions
- Research and development partnerships in the academic environment
- The ability to provide high-level consulting services in addition to software products
- A proven factory management and control software system acquired from Tandem that has been improved and upgraded to provide workflow, material services and labor services capabilities

b. Company Background

The company was founded in 1985 to provide manufacturing control systems. It operates out of one location and has fewer than 20 people, but has business in other regions of the U.S.

c. Key Products and Services

The software system that Factorial originally acquired from Tandem has been generalized and provided for workstations/PCs running under OS/2 as well as for Tandem computers running under Guardian and SQL.

The system, now called the Paperless Factory System, includes:

- A knowledge-based management and control system that provides on-line tracking, routing, data collection, resource management, quality control, configuration management and interfaces to other systems and equipment
- A material control system that provides just-in-time and traditional methods of inventory replenishment as well as inventory management, control, accounting and other functions
- A time and attendance and labor reporting system that operates on a standalone basis or integrated with the functions listed above

9. Sterling Software, Inc.—EDI Group, 4600 Lakehurst Court, P.O. Box 7160, Dublin, OH 43017 (614) 793-7000

a. Company Strategy

Sterling's EDI Group has developed and acquired a comprehensive set of EDI services and related software and services that have established the company as a major competitor and source of expertise in EDI.

As part of its strategy, the EDI Group focuses on maintaining a close relationship with clients and supplying their needs as their use of EDI expands. This strategy is supported with education and participation in the largest user group activity in the EDI market.

Markets that the EDI Group has penetrated include wholesale and retail distribution—including grocery, hardware and housewares as well as pharmaceutical, medical/surgical distribution and service merchandising.

b. Company Background

The EDI Group was created in October, 1990 and includes the ORDERNET Services Division, the EDI Labs Division, and an EDI

International Division, headquartered in London. The REDINET Services Division of CDC was acquired in 1991 and folded into the ORDERNET Division. Fiscal year 1991 revenues were over $30 million, with 85% of revenues coming from the U.S.

c. Key Products and Services

About 55% of the EDI Group's revenue comes from software products and 45% from network services. Both software products and network services are offered though the ORDERNET division to over 2,700 customers in the pharmaceutical, grocery, hardware and housewares, retail, medical distribution, mass merchandising, warehousing, transportation and automotive industries.

ORDERNET provides an on-line network to manage and control the flow of standardized business documents among over 2,000 trading partners.

Services to certain industries are provided through vendors active in those industries. ORDERNET services are made available to hospitals through GTE Health Systems. Services including a data base on drug usage are made available to the medical industry through International Health Applications. Internetwork traffic for the grocery industry is supported through BT Tymnet.

Electronic transmission of chargeback information between wholesalers and pharmaceutical manufacturers is provided in three formats established by national druggists' associations.

Translation between established standards for EDI and other standards in use and between a variety of record formats, as well as support of existing protocols on different hardware platforms, are provided with software from the EDI Group.

A data base service is also available to build on EDI documents, including purchase orders and invoices that trading partners use during business.

Security services, education and software maintenance are also offered in support of EDI products and services.

10. Symix Systems, Inc., 2400 Corporate Exchange Drive, Columbus, OH 43231 (614) 895-0738

a. Company Strategy

Symix has developed and is marketing a turnkey system that meets the needs of "make-to-order" manufacturers. The system, which is called Symix, is an integrated manufacturing control, accounting and financial system.

Although Symix is sold primarily with IBM and Hewlett-Packard computers, it could be sold with a variety of other equipment.

- The system is written in a 4GL relational data base language and will run on 300 hardware platforms that use the UNIX operating system, including IBM, HP, DEC, NCR, and Sun equipment.
- The system can also be delivered in versions that will run with VMS and DOS and on LANs using Novell's NetView.

b. Company Background

Symix Systems was founded in 1979 to develop and market manufacturing software for minicomputers. The company developed its Symix system in 1986 and began to market it in 1988. Revenue for 1991 rose to $25 million, over 65% above revenue for the prior year. An IPO was offered in March 1991.

c. Key Products and Services

Other than being a VAR for IBM and HP, the company's business is focused on its Symix software product. There was an earlier product of this type that the company sold after it was founded.

The modules of Symix perform the following functions:

- Inventry control and data collection
- Customer order entry
- Product configuration
- Purchasing
- Shop floor control and data collection
- Time and attendance data collection
- Advance manufacturing/MRP
- Engineering change notice
- Accounting and financial management, including payroll and fixed assets

VI

Conclusions and Recommendations

A

Industry and Market Conclusions

The current business interests in the discrete manufacturing industry have promoted a high level of interest in several trends emerging in the use of information systems, including downsizing, client/server technology and outsourcing. These trends will have an impact on the use of information services vendors as well as upon the functional organization of activities in the discrete industry.

- The business interests that are promoting this interest are: a need for more interconnection and access to data to improve service; quality of manufacturing and speed of response between manufacturing functions; and a driving need to eliminate redundant files of data with timing and other differences, and redundant steps of processing required to update and use these files.

- The inability to share data between marketing, service and product management, or engineering and manufacturing functions, makes it difficult to respond to product problems, plan field changes or plan upgraded products.

These deficiencies are having an impact upon discrete manufacturing during a time of weak sales and strong international competition from companies equipped with more responsive capabilities.

In a number of discrete manufacturing companies, where functions are constrained by large application systems and the time it takes to enhance or replace them, there is rising interest in outsourcing information systems functions to vendors that have experience in addressing these deficiencies and the knowledge and ability to discuss problems and solutions with prospects.

- In fact, some of the larger vendors serving the discrete industry, such as Andersen Consulting and EDS, are providing demonstrations and presentations to users that show them how operations can be improved.
- Several vendors of manufacturing software systems now have enhanced means of walking users through solutions to problems, such as the Power Bench product of Computer Associates.

Client/server technology and downsizing have also been found to be of considerable interest in addressing these deficiencies at a grass-roots level. The use of client/server technology is making it possible to collect and store data once and have it available for use by other functions on a timely basis.

- Client/server technology has a high level of penetration in all submarkets of discrete manufacturing, providing a path between activities in business, engineering and factory floor activities. Although its use is early in the life of this technology, the level of interest seems warranted by the promised benefits in information architecture and access.
- Together with downsizing of segments of application processing to functional units, client/server technology makes it possible for tasks to be handled more rapidly and with greater attention, because the results of the manipulation of data can be immediately available in numeric, graphic, image or modeling/decision-making presentations.

The interest in downsizing and client/servers is providing an opportunity for smaller vendors that can provide software products or commercial services to users. Only a small number of the larger SI and professional services vendors have launched strong moves to take advantage of the situation.

B

User Issues and Recommendations

The use of downsizing can cause structural changes in application systems. It has been found that segments of an application can be downsized to a group with a client/server unit and handled more efficiently or with overall improvements there.

- Corporate management in discrete manufacturing should facilitate and observe efforts by user groups to improve performance. These efforts could improve quality, service and productivity as well as indicate directions in which the automation and integration of functions should proceed. This may prove to be more efficacious than using a blueprint laid down by a planning group or vendor that has not been involved in the problems and challenges of work groups.

- Vendors should also review what is happening in functional groups interested in downsizing and client/servers, in addition to promoting their products, services and industry plans. They could find new vendors in their accounts that are interested in these developments.

To promote this approach and to integrate manufacturing functions, it will be necessary to utilize a relational data base management capability as well as application systems or feeder systems that handle all the functional types of data that can be found in a manufacturing enterprise.

- In larger enterprises, this could entail 19 or more categories of application data, according to vendors such as Oracle and ASK that have addressed the issue.
- The type of capability being envisioned is an approach to computer-integrated manufacturing, or CIM, which is referred to as enterprise resource planning by vendors and users involved in planning its use.

Vendors and IS staffs involved in discrete manufacturing should examine these developments because they could offer further insight into the discrete industry and suggest approaches that should be considered.

Questions have been raised by respected industry groups about the payback from efforts to achieve CIM.

- Efforts that involve getting into application systems and functions in all islands of automation in discrete manufacturing appear necessary to plan means of achieving CIM.
- One of the means of moving further in that direction is through the use of client/server technology and downsizing.

The use of more network capabilities embraces not only the connection of activities within a plant or company, but also connection to the activities of suppliers and customers.

- Between organizations, it would address the use of EDI and the integration of manufacturing activities between companies, including JIT supply and segmented manufacturing.
- The integration of activities between companies has been recommended as a means of responding to the productivity achieved by Japanese firms. It could be the alternative to arrangements with keiretsu in Japanese industry.

Discrete manufacturers and the information services vendors serving them must consider strategic, architectural and resource issues in the use of information systems as the use of networks, client/server applications and downsizing grows.

- Architectural and resource issues, which include technical expertise and investments in information technology, may make it necessary to consider the question of outsourcing to a larger extent or using a vendor in a partnership arrangement.

- The strategic issue involves the extent to which manufacturing functions can be restructured in response to current technological trends. Vendors should participate in this issue also.

The conclusions and recommendations just discussed are listed in Exhibit VI-1.

EXHIBIT VI-1

Conclusions and Recommendations

Conclusions

- High level of user interest in client/server use, downsizing and outsourcing
- Need for data in multiple areas promotes client/server use
- Need for responsiveness and improved productivity drives client/server use and downsizing
- Financing pressures related to changes in a complex information technology environment promote consideration of outsourcing
- Client/server and downsizing aid offers an opportunity to many information services vendors

Recommendations

- User efforts to find means of improving performance through client/server use and downsizing should be supported
- Planning to support the data management and interconnection needs of user functions should be initiated
- User initiatives and growing interconnection with suppliers and users should be factored into planning to integrate and reshape manufacturing functions

A

Definitions

No industry-specific definitions have been used in this report.

See the separate volume, INPUT's *Definition of Terms*, for general definitions of industry structure and delivery modes used throughout INPUT reports.

B

Forecast Data Base

Exhibit B-1 presents the forecast data base for the discrete manufacturing sector.

EXHIBIT B-1

Discrete Manufacturing Sector
User Expenditure Forecast by Delivery Mode, 1991-1997

Delivery Modes	1991 ($ M)	Growth 90-91 (%)	1992 ($ M)	1993 ($ M)	1994 ($ M)	1995 ($ M)	1996 ($ M)	1997 ($ M)	CAGR 92-97 (%)
Sector Total	11,858	10	13,100	14,593	16,263	18,173	20,414	22,928	12
Processing Services									
- Transaction Processing	838	4	875	915	956	994	1,038	1,077	4
Turnkey Systems	2,798	11	3,097	3,404	3,727	4,084	4,509	4,975	10
Applications Software Products	1,967	13	2,224	2,530	2,881	3,295	3,799	4,380	14
- Mainframe	383	7	410	442	467	492	524	557	6
- Minicomputer	1,046	11	1,158	1,260	1,389	1,522	1,685	1,865	10
- Workstation/PC	538	22	656	820	1,025	1,281	1,590	1,958	24
Systems Operations	574	18	688	235	1,000	1,200	1,420	1,680	20
Systems Integration	1,136	19	1,346	1,620	1,953	2,355	2,915	3,536	21
Professional Services	4,459	7	4,766	5,163	5,593	6,059	6,505	7,000	8
Network Services	86	21	104	126	153	186	228	280	22
- Electronic Info. Svcs.	43	19	51	61	73	87	105	127	20
- Network Applications	43	23	53	65	80	99	123	153	24

EXHIBIT B-2

Discrete Manufacturing Sector
1992 MAP Data Base Reconciliation

Delivery Modes	1991 Market				1996 Market				91-96 CAGR per data 91 rpt (%)	91-96 CAGR per data 92 rpt (%)
	1991 Report (Fcst) ($ M)	1992 Report (Actual) ($ M)	Variance from 1991 Report ($ M)	Variance from 1991 Report (%)	1991 Report (Fcst) ($ M)	1992 Report (Fcst) ($ M)	Variance from 1991 Report ($ M)	Variance from 1991 Report (%)		
Total Discrete Manufacturing Sector	11,858	11,858	0	0	20,967	20,414	-553	-3	12	12
Processing Services	838	838	0	0	1,038	1,038	0	0	4	4
Turnkey Systems	2,798	2,798	0	0	4,715	4,509	-206	-4	11	10
Applications Software Products	1,967	1,967	0	0	3,799	3,799	0	0	14	14
Systems Operations	574	574	0	0	1,400	1,420	+20	+1	20	20
Systems Integration	1,136	1,136	0	0	3,042	2,915	-127	-4	22	21
Professional Services	4,459	4,459	0	0	6,705	6,505	-200	-3	0	8
Network Services	86	86	0	0	268	228	-40	-2	26	22

The actual 1991 market is identical with the estimated market, because the estimation was made near the end of 1991.

Estimates of the 1996 market for SI, professional services, turnkey and network services have been reduced by 4% or less. Turnkey services will be separated into software products and workstations, reducing turnkey revenues.

The projection of continuing economic problems has led to decreases in projections for SI, professional services, and network services. Although the CAGR has not changed, a slight increase has been made for the projection of SO to account for the cost savings appeal of SO alternatives.

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INPUT provides planning information, analysis, and recommendations for the information technology industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions.

Subscription services, proprietary research/consulting, merger/acquisition assistance, and multiclient studies are provided to users and vendors of information systems and services. INPUT specializes in the software and services industry which includes software products, systems operations, processing services, network services, systems integration, professional services, turnkey systems, and customer services. Particular areas of expertise include CASE analysis, information systems planning, and outsourcing.

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